FCC Test Firm Designation Number: FR0014
Industry Canada Test Firm Number: Site# 9545A-1 / 9545A-2

Matériel testé : *Equipment under test*:	***SORHEA / PIRAMID CONNECT (PIRAMID XL3)*** *(Trademark / Marketing name or product reference)*

Client / Demandeur:
Customer / Applicant :
SORHEA
M. Aymeric CARADEC
1, rue du Dauphiné
69120 Vaulx-En-Velin - France

Fabricant :
Manufacturer:
SORHEA
1, rue du Dauphiné
69120 Vaulx-En-Velin - France

Numéro d'affaire :
Work number :
12407

Référence de la proposition :
Proposal number:
032018-22954

Date de l'essai :
Date of test:
8 octobre 2018
October 8th, 2018

Objectif des essais :
Test purpose:
EMC qualification accordingly to following standards:
- CFR 47, FCC Part 15, Subpart C
(Chapter 15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz)
- Industry Canada RSS-247, Issue 2
(Digital Transmission Systems Operating in the Bands 2400-2483.5 MHz)

Lieu du test:
Test location:
SMEE, Rue de Taille
38500 VOIRON - France

Test réalisé par :
Test realized by:
Laurent CHAPUS

Conclusion :
Conclusion:
L'équipement satisfait aux prescriptions des normes citées en référence.
The appliance complies with requirements of above mentioned standards.

Ed.	Date	Modifications / Pages	Written by : Visa	Approved by: Visa
1	January 30th, 2019	Initial Edition	Laurent Chapus  Signature numérique de Chapus Laurent	Régis ANCEL  Signature numérique de Ancel Régis

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Contents

1. Normatives References

FCC qualification according to:		
Standards	**Applied**	**Title**
ANSI C63.4 (2014)	X	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C63.10 (2013)	X	American National Standard for Testing Unlicensed Wireless Devices
CFR47, Part 15	X	Telecommunication – Federal Communication Commission – Radio frequency devices, Sections 15.109 / 15.209 / 15.247

ISED qualification according to:		
Standards	**Applied**	**Title**
ICES-003 (Issue 6/2016)	X	Information Technology Equipment (ITE) – Limits and methods of measurement
RSS-Gen (Issue 5/2018)	X	General Requirements and Information for the Certification of Radio Apparatus
RSS-247 (Issue2/2017)	X	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Note: Following guidance are used
- DTS Measurement Guidance 558074 D01 v05
- Determining ERP and EIRP Guidance 412172 D01 v01r01

Deviation from standard: None

2. Test synthesis

TEST	Paragraph number FCC Part 15 / IC RSS-247 / RSS-GEN	Spec. FCC Part 15 / IC RSS-247 / RSS-GEN	RESULTS (comments)
Conducted emissions test	15.207 (a) RSS-Gen § 8.8	Table 15.107 (a) Table 4 / RSS-Gen	**PASS**
Radiated emission test	15.209 (a) ICES-003	Table 15.209 (a) Table 5 , § 6.2	**PASS**
6dB Bandwidth	15.247 (a) (2) RSS-247 § 5.2 (a)	At least 500kHz	**PASS**
Maximum Peak Output Power	15.247 (b) (3) RSS-247 § 5.4 (d)	1W max / 30dBm (Conducted) 4W max / 36dBm (EIRP)	**PASS**
Maximum Power Spectral Density	15.247 (e) RSS-247 § 5.2 (b)	8dBm in a 3kHz band segment	**PASS**
Unwanted emissions into Non Restricted Frequency Bands	15.247 (d) / RSS-247 § 5.5	-20dBc in any 100kHz outside frequency band.	**PASS**
Unwanted emissions into Restricted Frequency Bands	15.209 (a) / 15.247 (d) / 15.205 (a) RSS-GEN § 7.1, §8.9, § 8.10 / RSS-247 § 5.5	Measure at 300m 9-490kHz: 2400µV/m/F(kHz) Measure at 30m 0.490-1.705: 24000µV/m/F(kHz) 1.705-30MHz: 30µV/m Measure at 3m 30MHz-88MHz : 40 dBµV/m 88MHz-216MHz : 43.5 dBµV/m 216MHz-960MHz : 46.0 dBµV/m Above 960MHz : 54.0 dBµV/m	**PASS**
Occupied Bandwidwth	RSS-GEN § 6.7	BW at 99%	**PASS**

- **General conclusion:**

Measures and tests performed on the sample of the product *SORHEA PIRAMID CONNECT (PIRAMID XL3)* , in configuration and description presented in this test report, show compliance with standards FCC CFR 47, PART 15, Subpart C and ISED RSS-Gen & RSS-247.

3. Equipment Under Test (EUT)

Nom / *Identification*	**PIRAMID CONNECT (PIRAMID XL3)**	Sn: CEM2

FCC ID: FCC ID: QVA-PIRCONNECT
IC: IC: 11664A-PIRCONNECT
Model: HVIN: PIRAMID XL3

Alimentation / *Power supply*

12V DC from external power supply

AC/DC power adapter used for test: Dong Guan City GangQi Electronic Co
Model:GQ15-120100-AG
Input:100-240 V -50/60 Hz 0.5Amax
Output:12V/1.0A (1m cable)

Auxiliaires / *Auxiliaries*

None

Entrées-Sorties / *Input / Output*

	Câbles pour essai / *Cables for test*	Blindé / *Shielded*	Prévu pour >3m / *Intended for >3m*
DC input cable (12V)	2 wires / 1m	No	Yes
Relay outputs (C/NC/NO)	6 wires / 1m	No	Yes

Version programme / *Firmware version*

NC

Mode de fonctionnement / *Running mode*

The tested sample is able to:
- Transmit a carrier frequency on low, middle and high channels (Bluetooth Low Energy)
- The microwave radar carrier frequency is always ON during testing (10.531GHz)

Programme de test / *Test program /*

None

Fréquence max interne EST / *Max internal EUT frequency*

50MHz (Except RF frequency)

Information sur l'équipement / Equipment information

- ISM Frequency band: 2400 to 2483.5 MHz (Tx & Rx, Wideband Data Transmission systems)
- BLE Power Setting: Power is set at is maximum rated output power (+3dBm)
- Modulation: Bluetooth Low Energy
- Antenna type: Integral (PCB trace, peak gain 0dBi)
- Powered by 12V DC from external power supply
- Equipment intended for use as a fixed station
- Equipment designed for continuous operation

4. Test conditions

Power supply voltage:
Equipment under test: 12V DC
Auxiliaries: 230V/50Hz (Radiated emission)
110V/60Hz (Conducted emission)

5. Modifications of the EUT

None

6. Special accessory

None

7. Measurement Uncertainty

Test Description	Expanded uncertainty
Conducted emissions test (150k-30MHz, AC mains)	± 3.5dB
Radiated emission test (9kHz-30MHz, electric field)	± 4.0dB
Radiated emission test (30-300MHz, OATS)	± 5.6dB
Radiated emission test (300-1000MHz, OATS)	± 5.3dB
Radiated emission test (1-40GHz, OATS / FAC)	± 5.6dB
Conducted RF output power at antenna port	± 1.6dB
Radiated RF output power (Peak, Power density)	± 5.6dB
DTS Bandwidth, 99% OBW	±4%
Temperature	± 1°C
Time and duty cycle calculation	±1%
AC and DC voltage	±1%

Note: Expended uncertainty at 95% confidence (k=2)

8. Field Strength Calculation

The field strength (level) is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follow:
FS = RA + AF + CF – AG
Where FS = Field Strength (Level)
RA = Receiver Amplitude (Meter Reading)
AF = Antenna Factor
CF = Cable Factor
AG = Amplifier Gain
Margin value = Emission level – Limit value

Example:
RA: 14.0dBµV / AF: 16.5 dBm^{-1} / CF: 3.5dB / AG: 15dB
→ Total factor: $5dBm^{-1}$
→ Field level: 19.0dBµV/m (-21.0dB for margin if limit is 40dBµV/m)

9. Conducted Emission Measurement (150kHz-30MHz)

TEST: Limits for conducted disturbance 150kHz – 30MHz	**Verdict**
Method: The LISN is placed 0,8 m from the boundary of the unit under test and bonded to a ground reference plane. This distance was between the closest points of the AMN and the EUT. All other units of the EUT and associated equipment were at least 0,8 m from the AMN. All power was connected to the system through Artificial Mains Network (AMN). Conducted voltage measurements on lines were made at the output of the LISN. The EUT is 80cm above the ground reference plane and 40cm from the vertical ground plane. The AC power cable is 1m length.	**Pass**

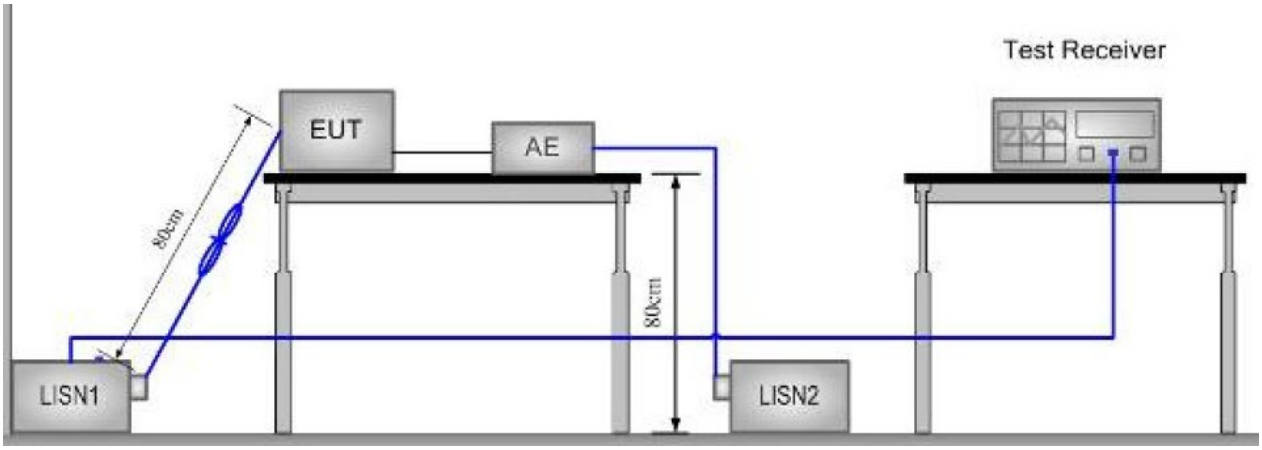
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	56% ± 5
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Point
	150kHz to 30MHz	AC input port (110V) Power adapter

Limits

Frequency (MHz)	Limit dB (µV)			
	Quasi-Peak	Result	Average	Result
0.15 – 0.50	66 \ 56	**PASS**	56 \ 46	**PASS**
0.50 - 5	56	**PASS**	46	**PASS**
5 – 30	60	**PASS**	50	**PASS**

Supplementary information:
Test location: SMEE
Test date: October 8th, 2018. Tested by L. CHAPUS
Power supply voltage: 12V from power adapter (AC mains 110V/60Hz)

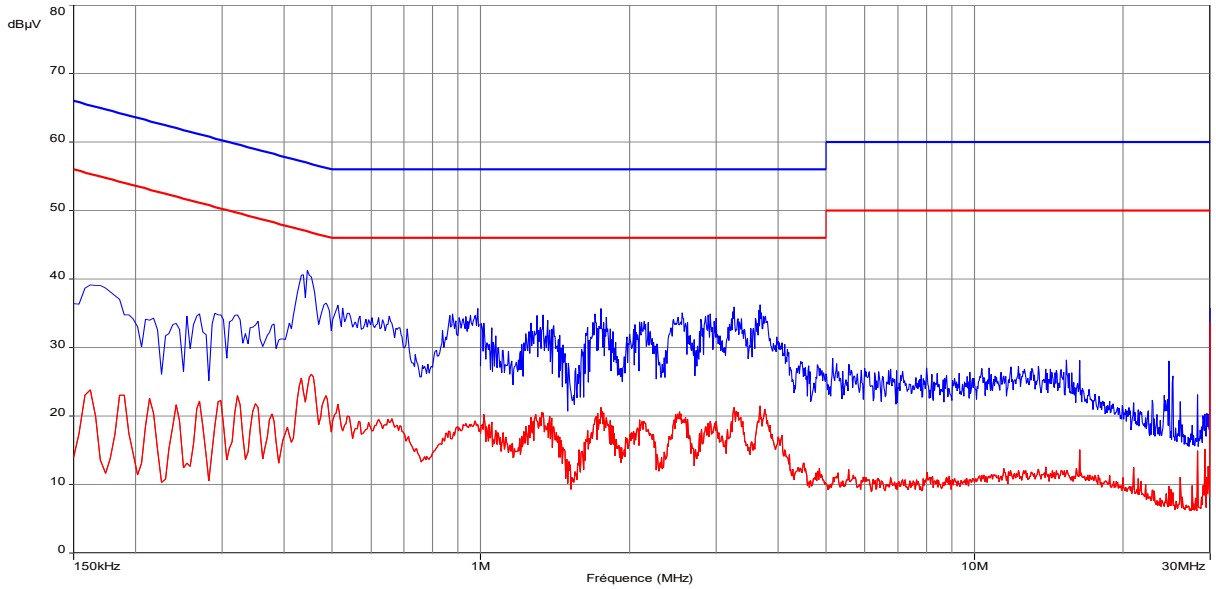
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator / limiter	SMEE	ATT#2	ATT-171-010	2018/6	2019/6
Cable RF	Div	1m	CAB-101-021	2018/4	2019/4
LISN (50Ω / 50µH) (Meas.)	AFJ	LS16C	RSI-101-001	2017/6	2019/6
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2017/5	2019/5
EMC Software	NEXIO	BAT EMC V3.8	SOF-101-001	-	-
AC power supply	PACIFIC POWER	AMX-125	ALI-101-002	-	-

Test Setup for conducted emission
 *Ground reference plane*

Tabulated Results for Mains Terminal Disturbance Voltage on AC port								
FREQ	**Meas. PK**	**Mes. QP**	**LIMIT QP**	**Margin QP**	**Mes. AV**	**LIMIT AV**	**Margin AV**	Line
(MHz)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dBµV)	(dBµV)	(dB)	
Levels are at least 20dB below limits								L1 / N

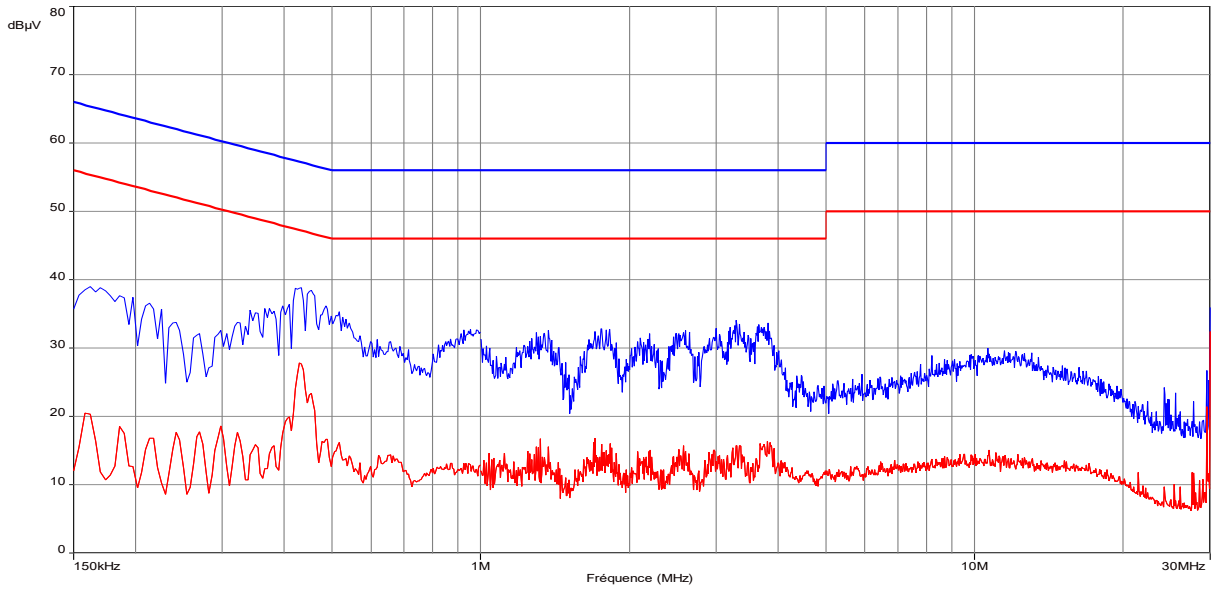
Frequency band investigated:	150kHz-30MHz
RBW:	9kHz
Voltage:	110V/60Hz
Limit:	FCC Part 15.209 a) / RSS-Gen: Issue 5, §8.8 Table 4
Final measurement detector:	Quasi-Peak and CISPR Average (AV)
RESULT:	PASS
Measured value calculation:	The measured value (level) is calculated by adding the Cable Factor, the Transient suppressor attenuation and LISN attenuation from the receiver amplitude reading. The basic equation is as follow: Meas. = RA + CF + ATT_{TRAN} + ATT_{LISN} Where Meas. = Level (dBµV) RA = Receiver Amplitude CF = Cable Factor ATT_{TRAN} = Transient suppressor attenuation ATT_{LISN} = LISN attenuation Margin value = Emission level – Limit value (A negative margin shows compliance to limit)

Graphical representation of Conducted Disturbance Measurement (Peak and Average detection)
AC port, Line L1 – Power adapter



----: Peak	----: Average	

Graphical representation of Conducted Disturbance Measurement (Peak and Average detection)
AC port, Line Neutral – Power adapter



----: Peak	----: Average	

10. 6dB Bandwidth

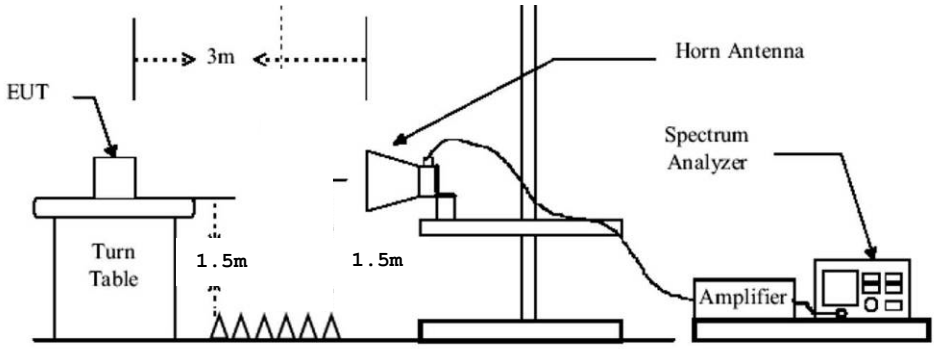
TEST: 6dB Bandwidth		**Verdict**
Method: The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. A radiated measurement is performed. The RBW is 100kHz, with VBW ≥ 3 x RBW. The SPAN is wide enough to capture all products of the modulation process. A MaxHold Peak detector is used. Automatic function of the spectrum analyser is used. The tested equipment is set to transmit operation with modulation on low, mid and high channels.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	56% ± 5

Limits – FCC Part 15.247 (a) / RSS-247 §5.2 (a)		
Frequency (MHz)	**Level for Bandwidth**	**Limit**
2402.0	6dB below the maximum output power	At least 500kHz
2440.0		
2480.0		

Supplementary information:
Test location: SMEE.
Test date: October 8th, 2018. Tested by L. CHAPUS

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
RF cable	Pasternack RF	PE302-120	CAB-131-024	2018/4	2019/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2018/4	2019/4
Anechoic chamber	COMTEST	214263	CAG-141-001	2017/6	2020/6
Turntable	Innco- Systems	CT0800	PLA-141-001	-	-
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2017/5	2019/5

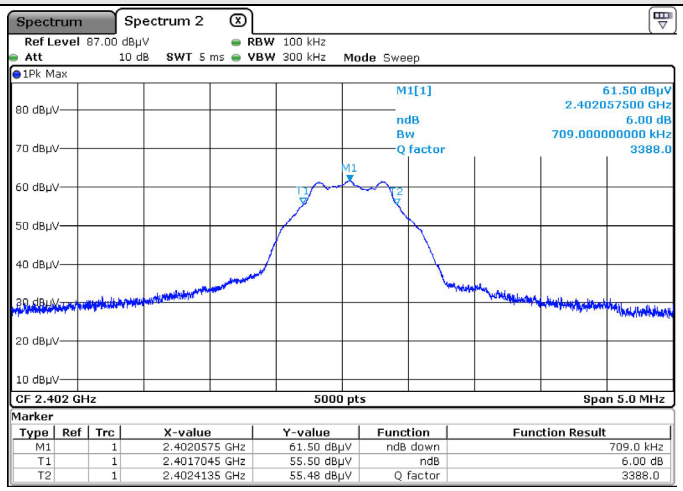
Test Setup for radiated emission



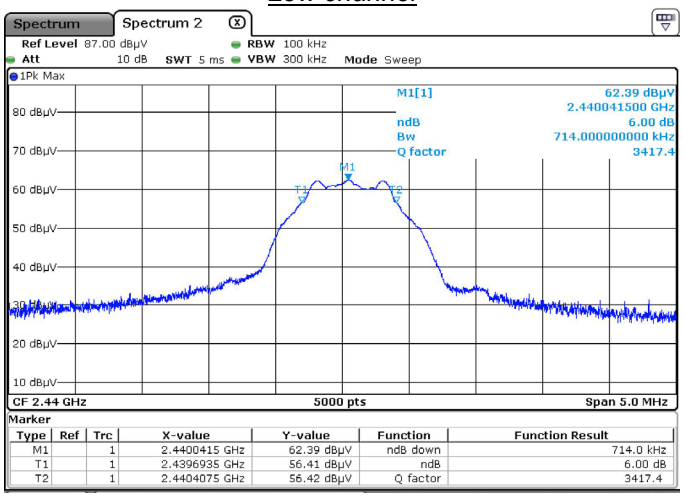
Test setup for 1-25GHz

Tabulated Results for Occupied Bandwidth		
Frequency (MHz)	**6dB Bandwidth** (kHz)	**Result**
2402.0	709.0	**Pass**
2440.0	714.0	**Pass**
2480.0	717.0	**Pass**

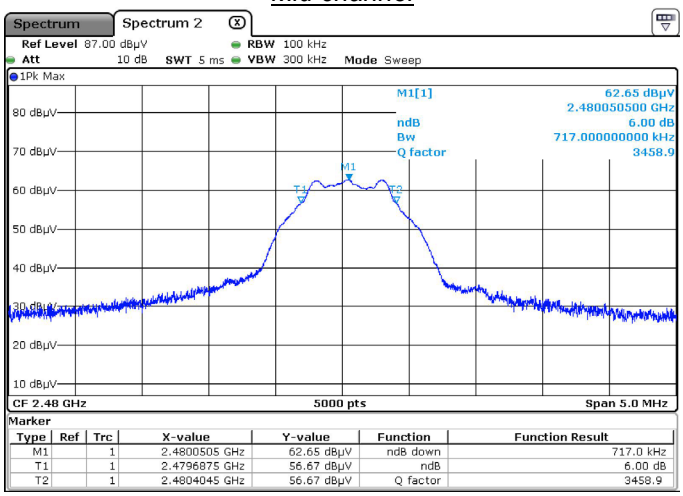
Graphical representation of 6dB Bandwidth



Low channel



Mid channel



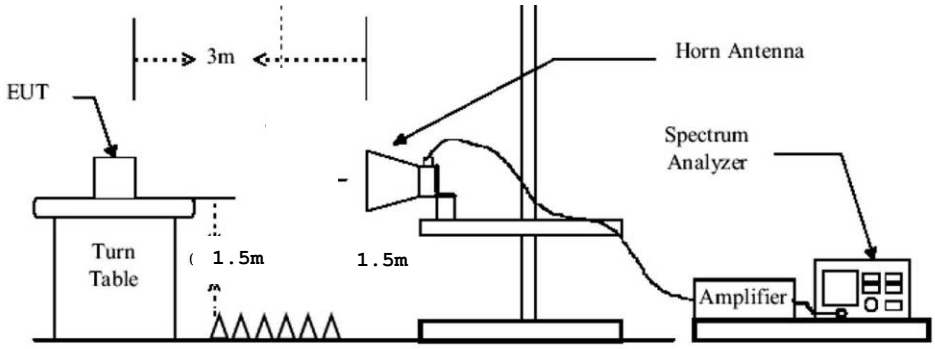
High channel

Frequency band investigated:	2400MHz to 2483.5MHz
RBW :	100kHz
Measurement detector :	Peak

11. Maximum Peak Output power

TEST: Maximum peak conducted output power			**Verdict**
Method: A radiated measurement is performed. The RBW is wide enough to capture the maximum amplitude level (1MHz). The SPAN is wide enough to capture all products of the modulation process. A MaxHold Peak detector is used. Radiated field strength of RF Output Power is measured at 3m in a Full Anechoic Chamber (FAC) that complies with ANSI C63.10. Maximum field strength (Peak) is performed by rotating the EUT 360°. All frequencies were investigated in both horizontal and vertical antenna polarity. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength, with a 60° rotation on each axis. (Clause 6.6.5 of ANSI C63.10). The tested equipment is set to transmit operation with modulation on low, mid and high channels.			**Pass**
Laboratory Parameters:	Required prior to the test		During the test
Ambient Temperature	20 to 30 °C		22°C ± 2
Relative Humidity	25 to 70 %		56% ± 5
Limits – FCC Part 15.247 (b) / RSS-247 §5.4 (d)			
Frequency (MHz)	Limits (dBµV/m)		
	Level / Detector	Results	
2400 to 2483.5	36 dBm / Pk / 3m (Radiated)	**Pass**	
2400 to 2483.5	30 dBm / Pk (Conducted)	**Pass**	
Supplementary information: Test location: SMEE. Test date: October 8th, 2018. Tested by L. CHAPUS			

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
RF cable	Pasternack RF	PE302-120	CAB-131-024	2018/4	2019/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2018/4	2019/4
Anechoic chamber	COMTEST	214263	CAG-141-001	2017/6	2020/6
Turntable	Innco- Systems	CT0800	PLA-141-001	-	-
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2017/5	2019/5

Test Setup for radiated emission

Test setup for 1-25GHz

Tabulated Results for Maximum peak output power (Radiated measurement)				
FREQ	**Field Strength 3m**	**Calculed EIRP**	**Limit**	**Result**
(MHz)	(dBµV/m)	(dBm)	(dBm)	
2402	96.7	1.5	36.0	**Pass**
2441	96.8	1.6	36.0	**Pass**
2480	96.8	1.6	36.0	**Pass**

RBW:	1MHz
Measurement distance:	3m
Limit:	FCC Part 15.247 / RSS-247
Final measurement detector:	Peak
RESULT:	PASS
Note:	(1): The field strength (level) is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follow: FS = RA + AF + CF – AG Where FS = Field Strength RA = Receiver Amplitude AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value (2): EIRP is calculated using the following equation: EIRP = E + 20xlog (D) – 104.8 – GR Where EIRP = Equivalent Isotropic Radiated Power in dBm E = Electric field strength in dBµV/m D = Measuring distance in meter GR = Ground reflection in dB (0dB above 1GHz)

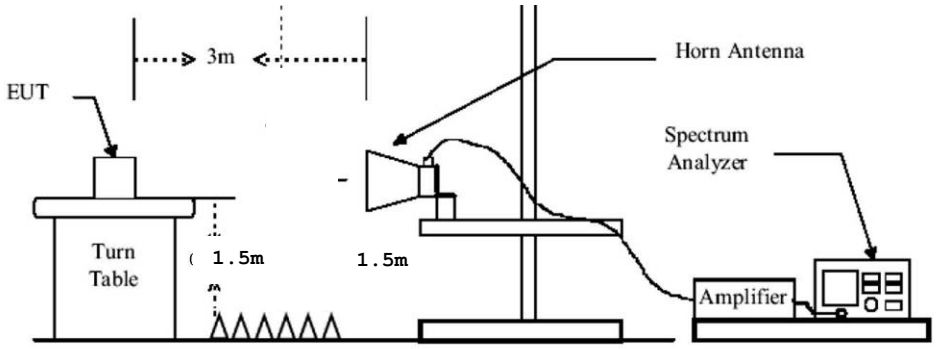
Tabulated Results for Maximum peak output power (Conducted)			
FREQ	**Conducted power**	**Limit**	**Result**
(MHz)	(dBm)	(dBm)	
2402	1.5	30.0	**Pass**
2440	1.6	30.0	**Pass**
2480	1.6	30.0	**Pass**

RBW:	1MHz
Limit:	FCC Part 15.247 / IC RSS-247
Final measurement detector:	Peak
RESULT:	PASS
Note:	(1): Maximum conducted Peak output power is calculated as follow: Pc = EIRP – G Where Pc = Conducted power dBm EIRP = Equivalent Isotropic Radiated Power in dBm G = Antenna gain in dBi (0dBi, as declared by the manufacturer)

12. Maximum Power Spectral Density Level in the fundamental emission

TEST: Maximum Peak Power Spectral Density		**Verdict**
Method: A radiated measurement is performed. The SPAN is wide enough to capture all products of the modulation process. Radiated field strength of RF Output Power is measured at 3m in a Full Anechoic Chamber (FAC) that complies with ANSI C63.10. Maximum field strength is performed by rotating the EUT 360°. All frequencies were investigated in both horizontal and vertical antenna polarity. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength, with a 60° rotation on each axis. (Clause 6.6.5 of ANSI C63.10). The tested equipment is set to transmit operation with modulation on low, mid and high channels.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	56% ± 5
Limits – FCC Part 15.247 (e) / RSS-247 §5.2 (b)		
Frequency (MHz)	**Level (Detector)**	**Limit**
2441.75	8 dBm/3kHz (Pk)	**Pass**
Supplementary information: Test location: SMEE. Test date: October 8th, 2018. Tested by L. CHAPUS		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
RF cable	Pasternack RF	PE302-120	CAB-131-024	2018/4	2019/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2018/4	2019/4
Anechoic chamber	COMTEST	214263	CAG-141-001	2017/6	2020/6
Turntable	Innco- Systems	CT0800	PLA-141-001	-	-
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2017/5	2019/5

Test Setup for radiated emission
 *Test setup for 1-25GHz*

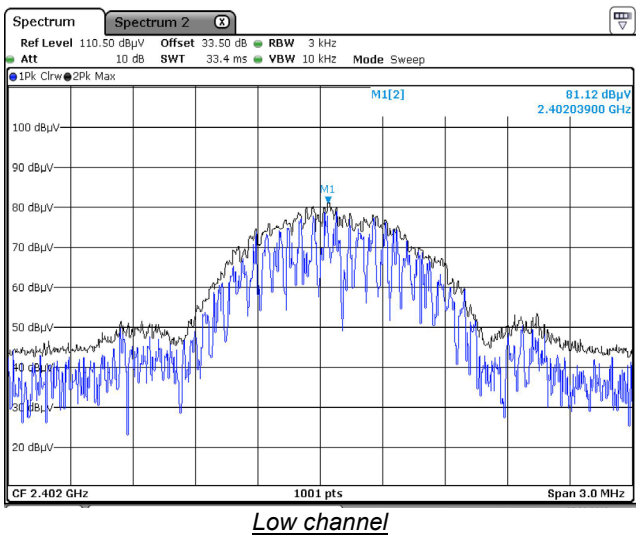
Tabulated Results for Maximum Spectral Density (Radiated measurement)				
FREQ	**Field Strength 3m**	**Calculated Radiated PSD (EIRP)**	**Limit**	**Result**
(MHz)	(dBµV/m)	(dBm)	(dBm)	
2402	81.1	-14.0	-	-
2440	81.9	-13.3	-	-
2480	82.3	-12.9	-	-

RBW:	3kHz
Measurement distance:	3m
Limit:	FCC Part 15.247 / RSS-247
Final measurement detector:	Peak
Note:	(1): The field strength (level) is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follow: FS = RA + AF + CF – AG Where FS = Field Strength RA = Receiver Amplitude AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value (2): EIRP/PSD is calculated using the following equation: EIRP = E + 20xlog (D) – 104.8 – GR Where EIRP = Equivalent Isotropic Radiated Power in dBm E = Electric field strength in dBµV/m D = Measuring distance in meter GR = Ground reflection in dB (0dB above 1GHz)

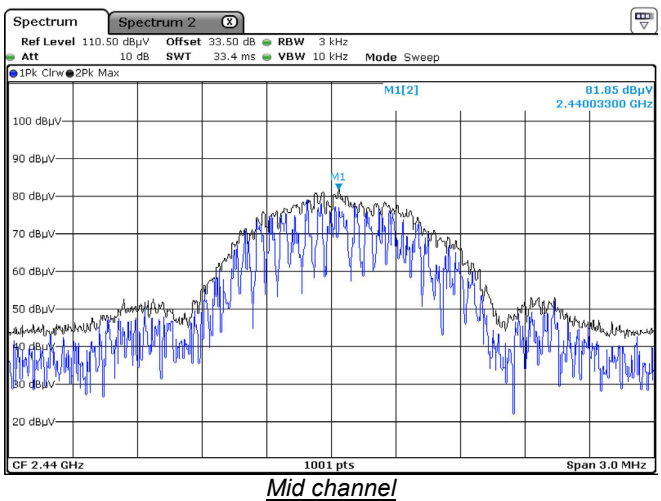
Tabulated Results for Maximum Conducted Power Spectral Density			
Frequency (MHz)	**PSD (dBm/3kHz)**	**Limit**	**Result**
2402.0	-14.0	8dBm/3kHz	**Pass**
2441.0	-13.3	8dBm/3kHz	**Pass**
2480.0	-12.9	8dBm/3kHz	**Pass**

RBW:	3kHz
Limit:	FCC Part 15.247 / RSS-247
Final measurement detector:	Peak
RESULT:	PASS
Note:	(1): Maximum conducted power spectral density is calculated as follow: P_{SD} = EIRP – G Where P_{SD} = Conducted power spectral density EIRP = Equivalent Isotropic Radiated Power in dBm G = Antenna gain in dBi (0dBi, as declared by the manufacturer)

Graphical representation for Maximum Power Spectral Density

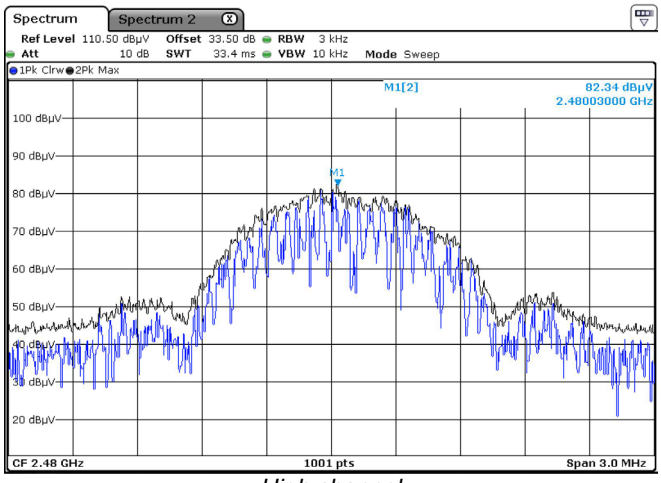


Low channel



Mid channel

Graphical representation for Maximum Power Spectral Density



High channel

RBW:	3kHz
Limit:	FCC Part 15.247 / RSS-247
RESULT:	PASS

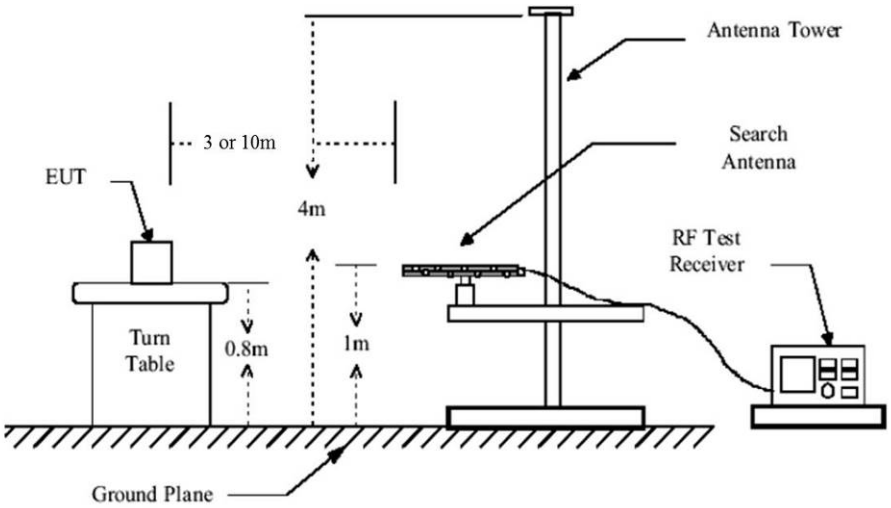
13. Unwanted emissions in Non-Restricted Frequency bands

TEST: Unwanted emissions in Non-Restricted Frequency Bands			**Verdict**
Method: Measurements were performed on a 3-meter Open Area Test Site (OATS) for frequency below 1GHz. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (Peak) were then performed by rotating the EUT on 360° and adjusting the receive antenna height from 1 to 4 m For frequency above 1GHz, final measurements were made at 3m in a Full Anechoic Chamber (FAC) that complies with ANSI C63.10. Measurements were performed at an antenna to EUT separation distance of 3 meter. The EUT was rotated 360° about its azimuth with the receive antenna in horizontal and vertical polarities. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength, with 60° rotation on each axis. (Clause 6.6.5 of ANSI C63.10). A pre-scan frequency identification of the EUT has been performed in full anechoic chamber. The measured radiated field of the EUT is performed (or corrected) at 3-meters of distance. Antenna is 1.25-meters high. The pre-characterization graphs are obtained in PEAK detection with 360° continuous rotation of the device under test.			**Pass**
Laboratory Parameters:	Required prior to the test		During the test
Ambient Temperature	20 to 30 °C		22°C ± 2
Relative Humidity	25 to 70 %		56% ± 5
Fully configured sample scanned over the following frequency range	Frequency range on each side of line		Measurement Point
	30MHz – 25GHz		3 m measurement distance
Limits – FCC Part 15.247 (d) / RSS-247 § 5.5			
Frequency (MHz)	Limits (dBµV/m)		
	Detector / Analyser RBW	Limit	Results
30 to 25000	Pk / 100kHz	20dB below the maximum Peak level	**Pass**
Supplementary information: Test location: SMEE. Test date: October 8th, 2018. Tested by L. CHAPUS			

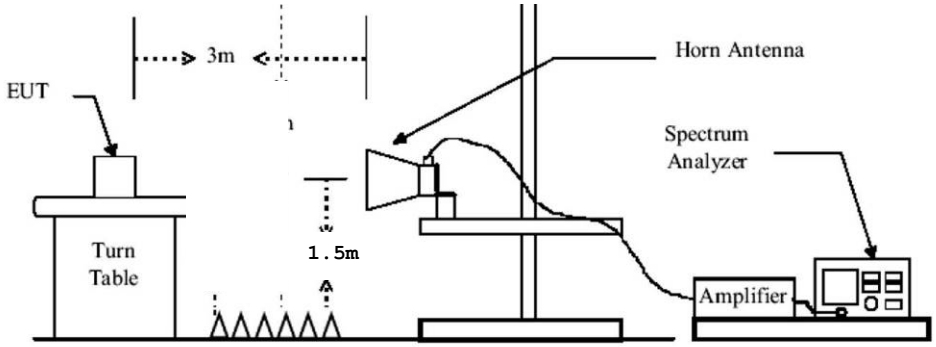
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Log-periodic antenna	TDK	PLP3003	ANT-101-001	2017/5	2019/5
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2017/5	2019/5
Loop antenna	EMCO	6502	ANT-101-009	2017/8	2019/8
BiConiLog antenna	EMCO	3142B	ANT-101-010	2017/7	2019/7
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
Horn antenna	ETS-LINDGREN	3116	ANT-161-014	2017/12	2022/12
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2017/5	2019/5
RF cable	Div	OATS/25m	CAB-101-017	2018/4	2019/4
RF cable	Pasternack RF	PE302-120	CAB-131-024	2018/4	2019/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-026	2018/4	2019/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-029	2018/4	2019/4

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2018/4	2019/4
RF cable	HUBER+SUHNER	SF102 (K/2m)	CAB-171-034	2017/5	2019/5
RF cable	HUBER+SUHNER	SF102 (K/3m)	CAB-171-035	2017/5	2019/5
Anechoic chamber	COMTEST	214263	CAG-141-001	2017/6	2020/6
Antenna mast	Innco- Systems	MA4000EP	MAT-101-001	-	-
Turntable	Innco- Systems	DS1200S	PLA-101-001	-	-
Turntable	Innco- Systems	CT0800	PLA-141-001		
Pre-amplifier	PE	1524	PRE-101-002	2018/4	2019/4
Pre-amplifier	SMEE	18-40GHz	PRE-171-004	2017/12	2019/12
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-003	2017/5	2019/5
OATS	Div	10m	SIT-101-001	2017/7	2020/7
EMC Software	NEXIO	BAT EMC V3.8	SOF-101-001	-	-

Test Setup for radiated emission



Test setup for 30-1000MHz

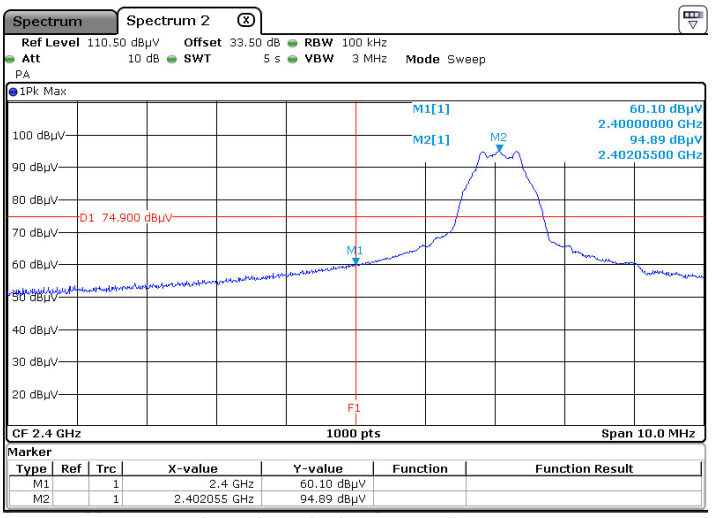
Test Setup for radiated emission
 *Test setup for 1-25GHz*

Tabulated Results for Peak Output Power Reference level	
FREQ	**Field Strength 3m**
(MHz)	(dBµV/m)
2402.0	94.9
2440.0	95.0
2480.0	95.0
RBW:	100kHz
Measurement distance:	3m
Limit:	Ref. level only – For 15.247 (d) / RSS-247 § 5.5
Final measurement detector:	Peak
Note:	(1): Only for identification of limit in non-restricted band Limit is **74.9 dBµV/m** Peak for out-of-band frequencies in Non-Restricted bands (with a 100kHz RBW on the spectrum analyser)

Tabulated Results for Unwanted emissions in Non-Restricted bands				
FREQ (MHz)	**Field Strength 3m** (dBµV/m)	**Limit** (dBµV/m)	**Margin** (dBµV/m)	**Result** (dBµV/m)
2399.942	60.1	74.9	**-14.8**	**Pass**
7206.000	57.4	74.9	**-17.5**	**Pass**

RBW:	100kHz
Measurement distance:	3m
Limit:	15.247 / RSS-247
Final measurement detector:	Peak
RESULT:	PASS
Note:	(1): The field strength (level) is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follow: FS = RA + AF + CF – AG Where FS = Field Strength RA = Receiver Amplitude AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value (2): Peak pre-scans not performed at 3-meters distance are corrected as follow: $M@3m = M@D_m + 20 \times \log (D_m / 3_m)$ Where D is the measurement distance in meter (3): All frequencies not specified have margin < -10dB (4): Worst case between charge mode and normal used mode (5): 3-axis measurement performed for device under test.

Graphical representation of Band-edge compliance (LOW)



Low bandedge compliance

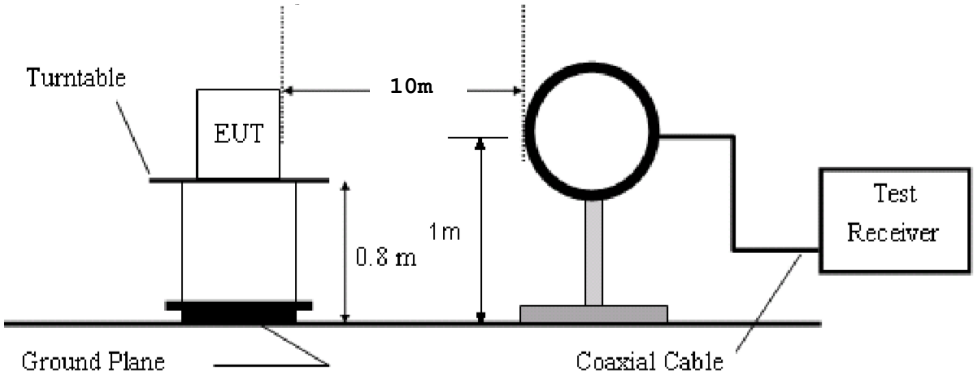
Radiated Peak level is 60.1dBµV/m (limit 74.9dBµV/m)
F1 = 2400MHz
RESULT: PASS
Note: radiated measurement (3m in FAC)

14. Unwanted emissions in Restricted Frequency bands

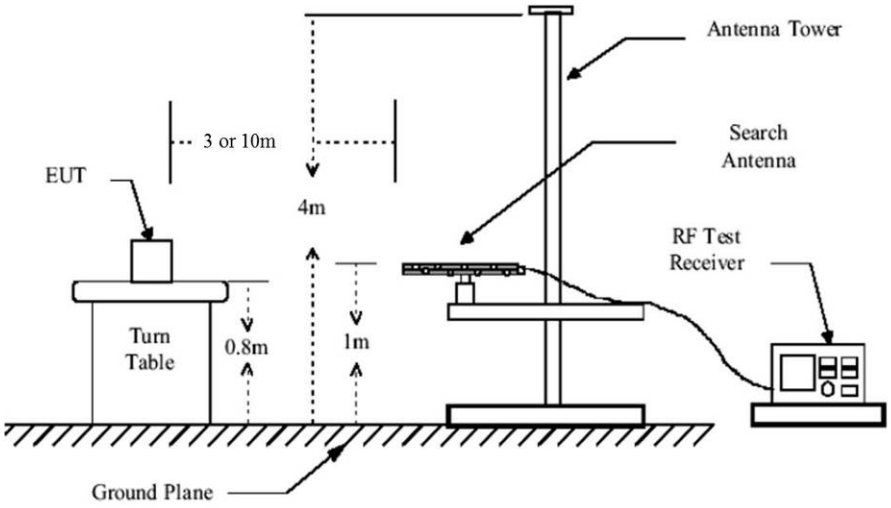
TEST: Unwanted emissions into Restricted Frequency Bands			**Verdict**
Method: Measurements were performed on a 3-meter Open Area Test Site (OATS) for frequency below 1GHz. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (Peak) were then performed by rotating the EUT on 360° and adjusting the receive antenna height from 1 to 4 m For frequency above 1GHz, final measurements were made at 3m in a Full Anechoic Chamber (FAC) that complies with ANSI C63.10. Measurements were performed at an antenna to EUT separation distance of 3 meter. The EUT was rotated 360° about its azimuth with the receive antenna in horizontal and vertical polarities. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength, with 60° rotation on each axis.(Clause 6.6.5 of ANSI C63.10). A pre-scan frequency identification of the EUT has been performed in full anechoic chamber. The measured radiated field of the EUT is performed (or corrected) at 3-meters of distance. Antenna is 1.25-meters high. The pre-characterization graphs are obtained in PEAK detection with 360° continuous rotation of the device under test.			**Pass**
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	20 to 30 °C	22°C ± 2	
Relative Humidity	25 to 70 %	56% ± 5	
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Point	
	9kHz – 30MHz	10 m measurement distance	
	30MHz – 25GHz	3 m measurement distance	
Limits – FCC Part 15.205, 15.209 (a), 15.247 (d) / RSS-GEN §8.9, §8.10, RSS-247 §5.5			
Frequency (MHz)	Limits (dBµV/m)		
	Level / Detector / Distance	Results	
0.009 to 0.090	107.6 – 87.6 / AV / 10m 127.6 – 107.6 / PK / 10m	**Pass**	
0.090 to 0.110	87.6 – 85.9 / QP / 10m	**Pass**	
0.110 to 0.490	85.7 – 72.9 / AV / 10m 105.7 – 92.9 / PK / 10m	**Pass**	
0.490 to 1.705	52.9 – 42.1 / QP / 10m	**Pass**	
1.705 to 30	48.6 / QP / 10m	**Pass**	
30 to 88	40.0 / QP / 3m	**Pass**	
88 to 216	43.5 / QP / 3m	**Pass**	
216 to 960	46.0 / QP / 3m	**Pass**	
960-1000	54.0 / QP / 3m	**Pass**	
Above 1GHz	54.0 / AV / 3m 74.0 / PK / 3m	**Pass**	
Supplementary information: Test location: SMEE. Test date: October 8th, 2018. Tested by L. CHAPUS			

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Log-periodic antenna	TDK	PLP3003	ANT-101-001	2017/5	2019/5
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2017/5	2019/5
Loop antenna	EMCO	6502	ANT-101-009	2017/8	2019/8
BiConiLog antenna	EMCO	3142B	ANT-101-010	2017/7	2019/7
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
Horn antenna	ETS-LINDGREN	3116	ANT-161-014	2017/12	2022/12
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2017/5	2019/5
RF cable	Div	OATS/25m	CAB-101-017	2018/4	2019/4
RF cable	Pasternack RF	PE302-120	CAB-131-024	2018/4	2019/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-026	2018/4	2019/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-029	2018/4	2019/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2018/4	2019/4
RF cable	HUBER+SUHNER	SF102 (K/2m)	CAB-171-034	2017/5	2019/5
RF cable	HUBER+SUHNER	SF102 (K/3m)	CAB-171-034	2017/5	2019/5
Anechoic chamber	COMTEST	214263	CAG-141-001	2017/6	2020/6
Antenna mast	Innco- Systems	MA4000EP	MAT-101-001	-	-
Turntable	Innco- Systems	DS1200S	PLA-101-001	-	-
Turntable	Innco- Systems	CT0800	PLA-141-001		
Pre-amplifier	PE	1524	PRE-101-002	2018/4	2019/4
Pre-amplifier	SMEE	18-40GHz	PRE-171-004	2017/12	2018/12
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-003	2017/5	2019/5
OATS	Div	10m	SIT-101-001	2017/7	2020/7
EMC Software	NEXIO	BAT EMC V3.8	SOF-101-001	-	-

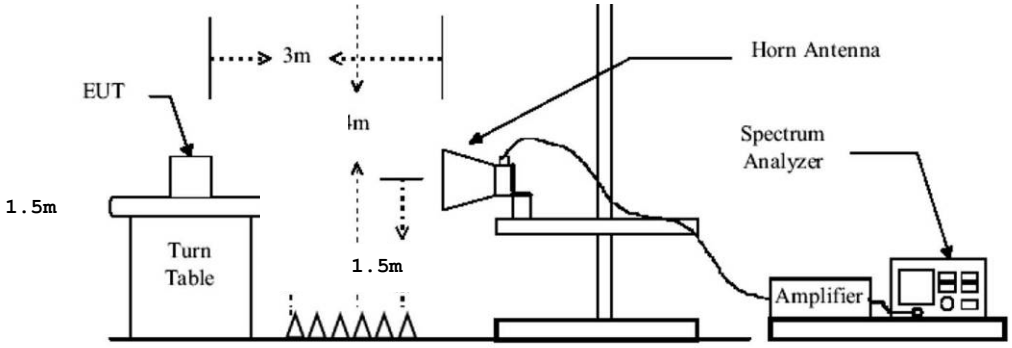
Test Setup for radiated emission



Test setup for 9k-30MHz



Test setup for 30-1000MHz



Test setup for 1-25GHz

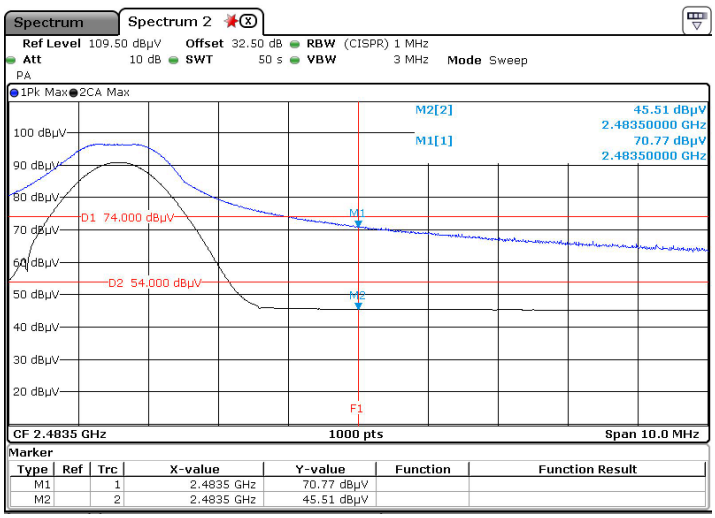
Tabulated Results for Unwanted emissions (9kHz-30MHz)						
FREQ	**RF field @ 30m**	**Limit @ 30m**	**Margin**	**Antenna angle**	**Table angle**	**Correc. Fact. (CF)**
MHz	(QP) dBµV/m	(QP) dBµV/m	dB	Degree	Degree	dB
Margin < -10dB						
Supplementary information: Frequency list measured on the Open Area Test Site has been created with pre-scan results.						

Frequency band investigated:	9kHz-30MHz
RBW:	200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)
Measurement distance:	10m
Limit:	FCC Part 15.205 - 15.209 / RSS-GEN
Final measurement detector:	Peak / Quasi-Peak / Average
Note:	CF: Correction factor = Antenna factor + Cable loss *1: Measure have been done at 10m distance and corrected according to requirements of 15.209.e) (M@30m = M@10m-19.1dB)

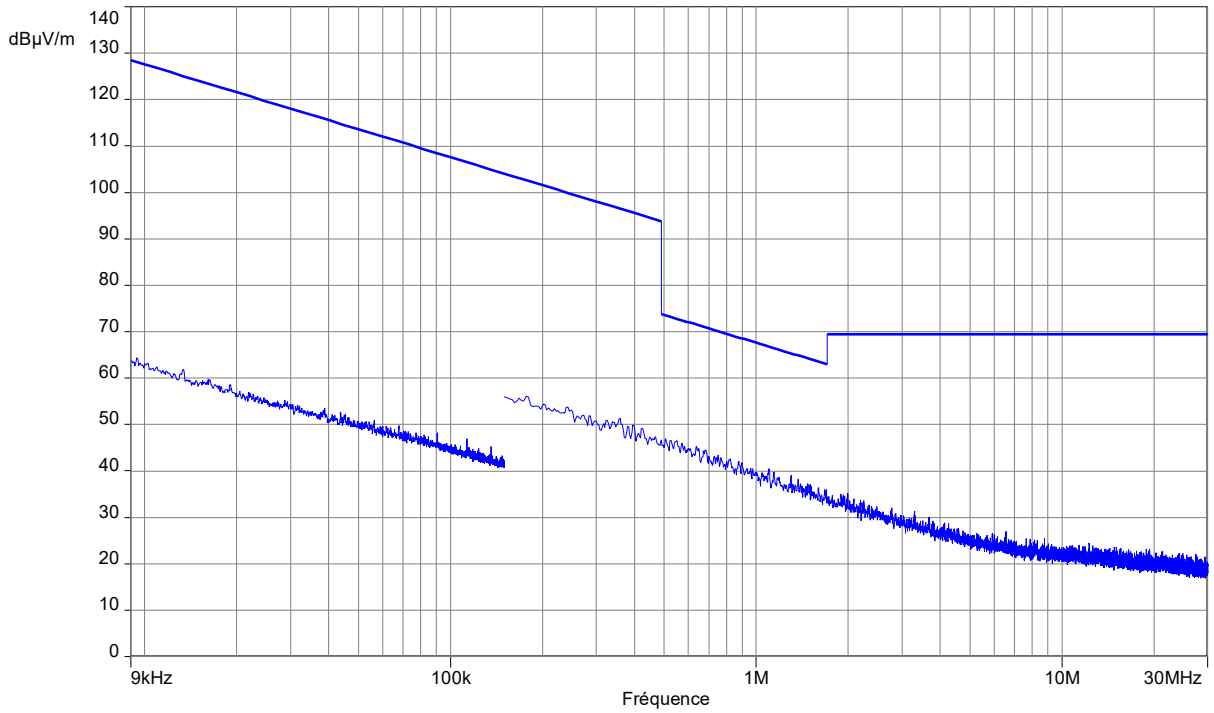
Tabulated Results for Unwanted emissions (30MHz-1GHz)										
FREQ	**Meter reading**	**Meter reading**	**Total factor**	**Field level**	**Field level**	**Pol**	**Antenna height**	**Table angle**	**Limit**	**Margin**
MHz	(QP) dBµV	(Pk) dBµV	dB	(QP) dBµV/m	(Pk) dBµV/m		cm	Degré	(QP) dBµV/m	dB
319.800	22.5	26.7	17.9	40.4	44.6	V	100	150	46.0	**-5.6**
337.500	20.1	26.4	19.4	39.5	45.8	V	120	120	46.0	**-6.5**
Supplementary information: Frequency list measured on the Open Area Test Site has been created with pre-scan results.										

Frequency band investigated:	30MHz-1GHz
RBW:	120kHz
Measurement distance:	3m
Limit:	FCC Part 15.205 - 15.209 / RSS-GEN
Final measurement detector:	Quasi-Peak
RESULT:	PASS
Field Strength Calculation:	The field strength (level) is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follow: FS = RA + AF + CF – AG Where FS = Field Strength RA = Receiver Amplitude AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value

Tabulated Results for Unwanted emissions (1GHz-25GHz)					
FREQ (MHz)	**Field Strength 3m** (dBµV/m)	**Detector**	**Limit** (dBµV/m)	**Margin** (dBµV/m)	**Result**
2483.5	70.8	Pk	74	-3.2	**Pass**
2483.5	45.5	Avg	54	-8.5	**Pass**
4804.0	58.6	Pk	74	-15.4	**Pass**
4804.0	47.3	Avg	54	-6.7	**Pass**
4882.0	59.7	Pk	74	-14.3	**Pass**
4882.0	48.1	Avg	54	-5.9	**Pass**
4960.0	59.9	Pk	74	-14.1	**Pass**
4960.0	48.8	Avg	54	-5.2	**Pass**
7323.0	57.4	Pk	74	-16.6	**Pass**
7323.0	45.9	Avg	54	-8.1	**Pass**
7440.0	58.1	Pk	74	-15.9	**Pass**
7440.0	46.3	Avg	54	-7.7	**Pass**
RBW / VBW		1MHz / 3MHz			
Measurement distance:		3m			
Limit:		FCC Part 15.205, 15.209, 15.247 / RSS-Gen, RSS-247			
Final measurement detector:		Peak / Average			
RESULT:		PASS			
Notes:		(1): The field strength (level) is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follow: FS = RA + AF + CF – AG Where FS = Field Strength RA = Receiver Amplitude AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value (2): Peak pre-scans not performed at 3-meters distance are corrected as follow: M@3m = M@Dm + 20 x log (Dm / 3m) Where D is the measurement distance in meter (3): All frequencies not specified have margin < -10dB (for peak and average detector)			

Graphical representation of Band-edge compliance (HIGH)
   *High bandedge compliance*
Radiated Peak level is 70.8dBµV/m (limit 74dBµV/m) Radiated Average level is 45.5dBµV/m (limit 54dBµV/m, CISPR Average detector measurement) RESULT: PASS Note: radiated measurement

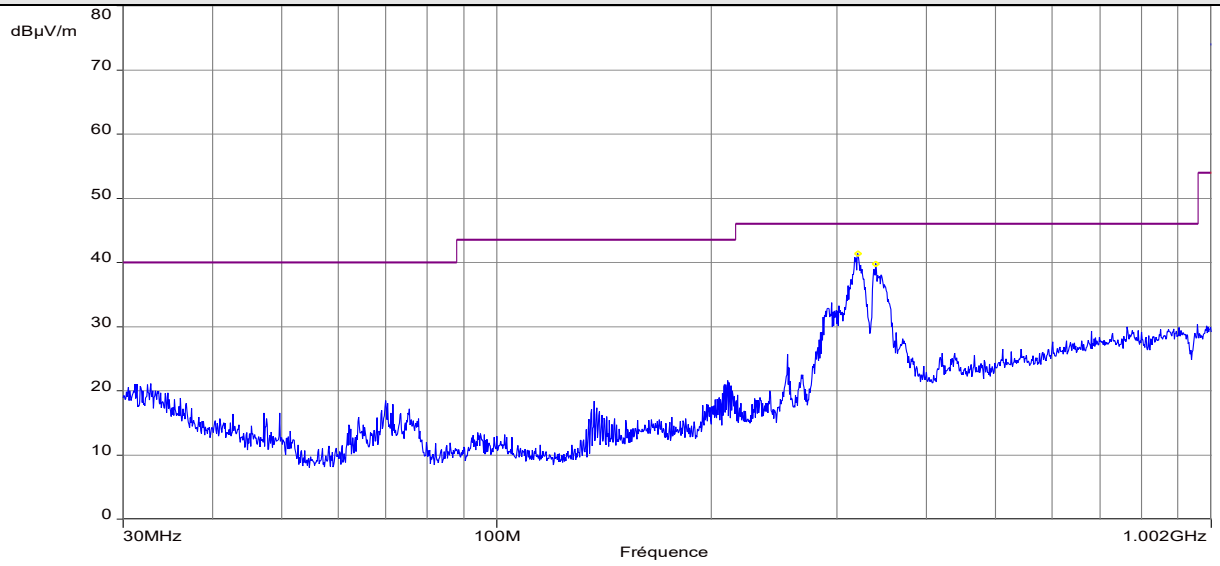
Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 9kHz-30MHz / 3m / Parallel & Perpendicular antenna position / Transmit mode)

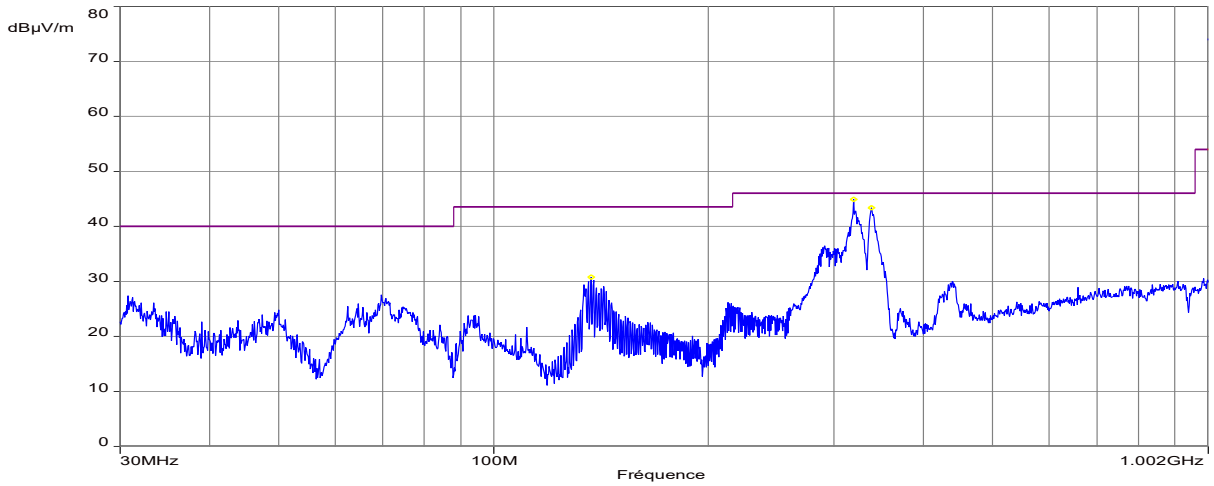


Notes: Pre-scan graph only for identification purpose.
Same result for transmit mode on all channels.

Frequency band investigated:	9kHz-30MHz
Unit :	dBµV/m
RBW :	200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)
Antenna polarization :	Parallel / Perpendicular to measurement axis
Measurement detector:	Peak

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 30MHz-1GHz / 3m / Horizontal & Vertical/ Transmit mode)





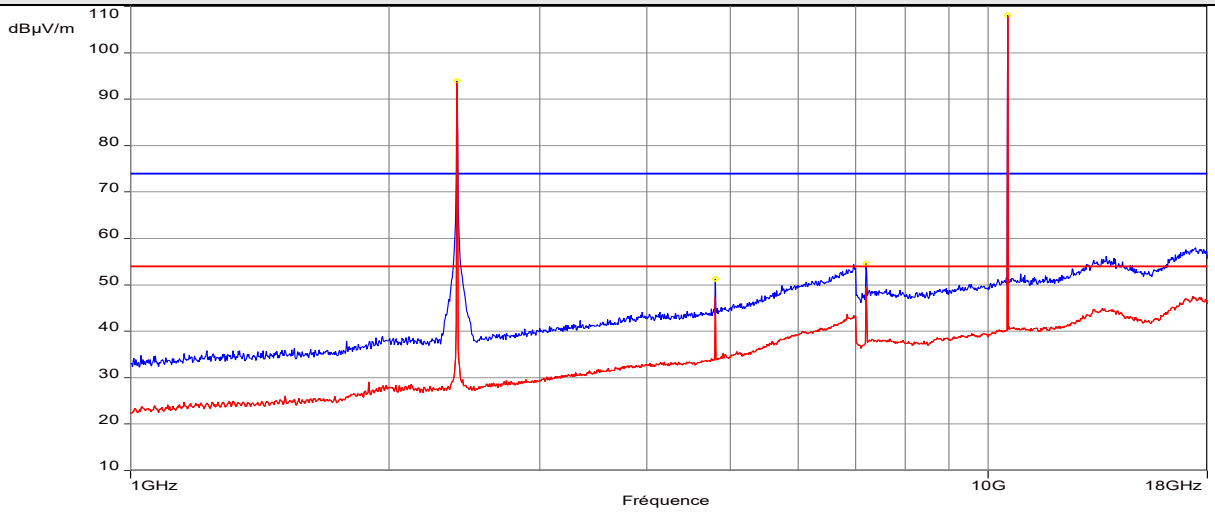
Note: Pre-scan graph only for identification purpose.
Same result for transmit mode on all channels

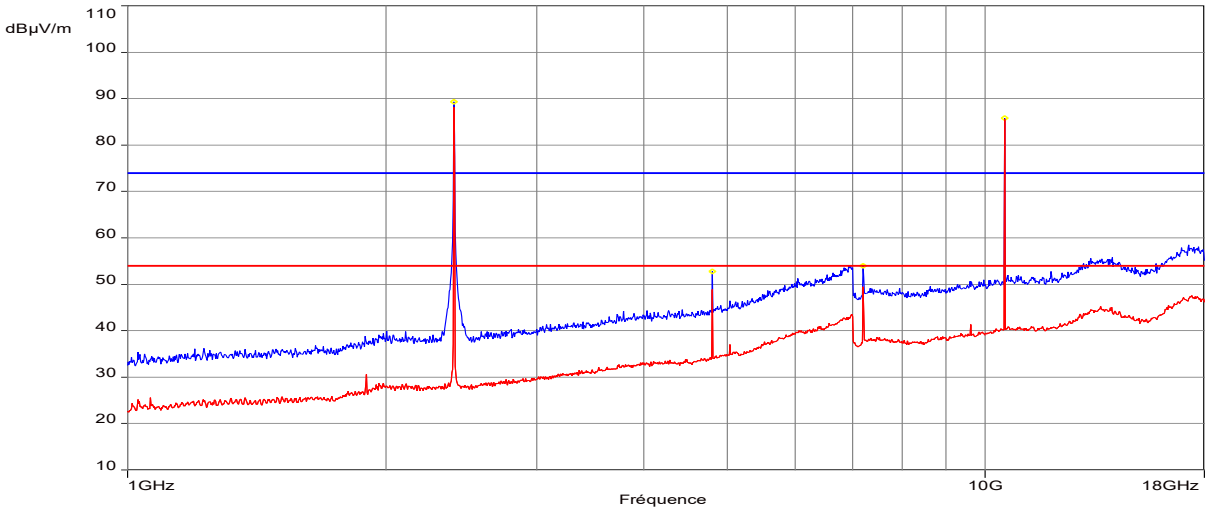
Frequency band investigated:	30MHz-1GHz
Unit :	dBµV/m
RBW :	100kHz
Antenna polarization :	Horizontal & Vertical
Voltage:	12V DC
Limit:	FCC 15.209 / RSS-GEN
Measurement detector:	Peak

PEAK LIST FROM PRE-SCAN

Frequency (MHz)	Peak Level (dBµV/m)	Angle (°)	Limit (dBµV/m)	Polarization	Comments
321.062	41.39	130.6	46.0	H	
339.592	39.79	115.2	46.0	H	
136.954	30.79	195.6	46.0	V	
319.452	44.87	149	46.0	V	
338.346	43.35	116.9	46.0	V	

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 1GHz-18GHz / 3m / Horizontal & Vertical/ Transmit mode) – Low channel



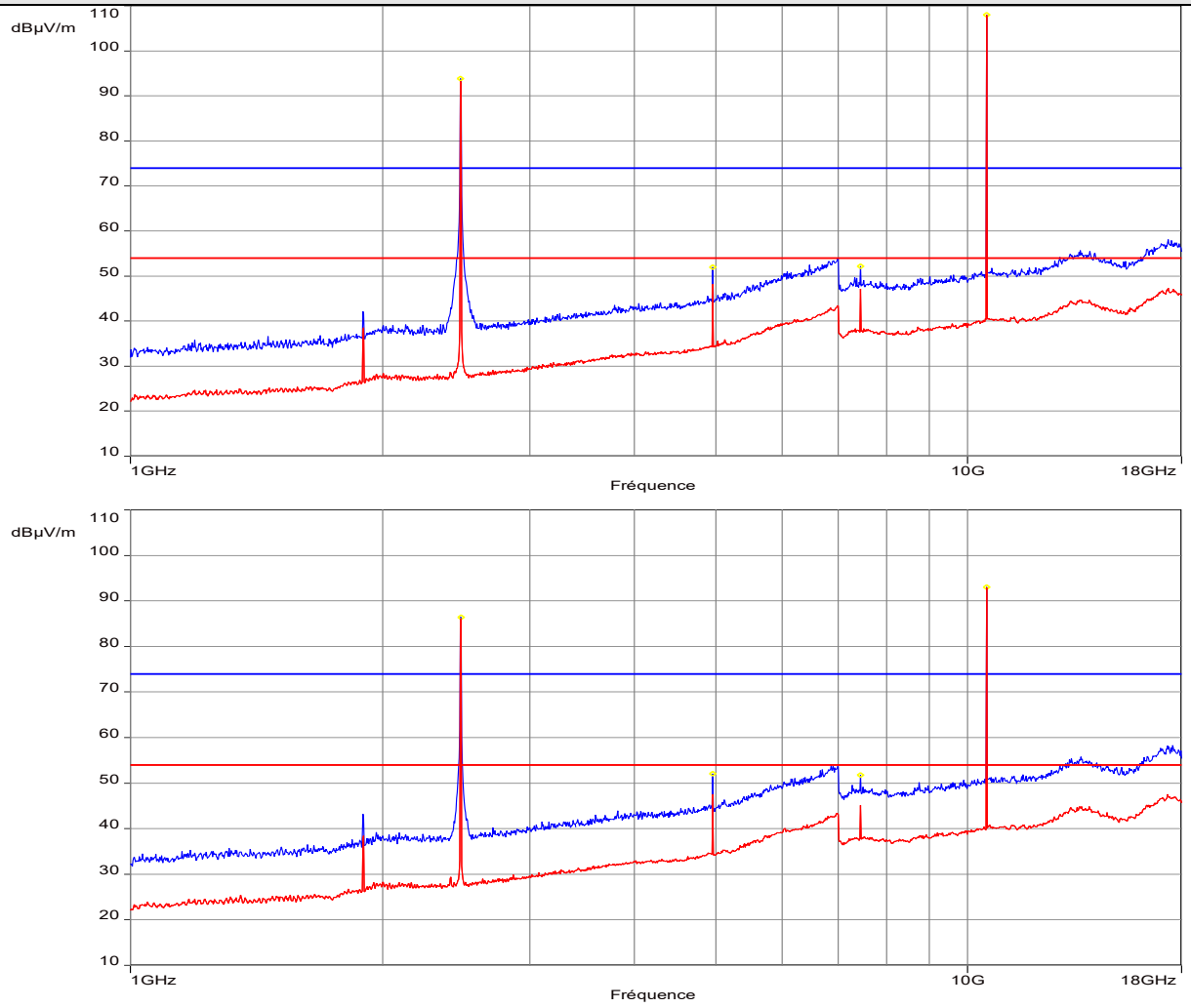


Note: Pre-scan graph only for identification purpose.

------ : Peak measure	------ : Average measure
Frequency band investigated:	1GHz-18GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal & Vertical
Voltage:	12V
Limit:	FCC 15.247 / RSS-247
Measurement detector:	Peak / Average

PEAK LIST FROM PRE-SCAN					
Frequency (MHz)	**Peak Level (dBµV/m)**	**Angle (°)**	**Limit (dBµV/m)**	**Polarization**	**Comments**
2401.79	93.98	191.9	74.0	H	RF / BLE carrier
4804.61	51.23	149.8	74.0	H	
7206.88	54.58	101.9	74.0	H	
10531.3	108.07	2.8	74.0	H	RF / MW radar carrier
2402.39	89.36	224.9	74.0	V	RF / BLE carrier
4803.58	52.74	68.3	74.0	V	
7206.67	53.98	163.2	74.0	V	
10531.5	85.81	16.4	74.0	V	RF / MW radar carrier

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 1GHz-18GHz / 3m / Horizontal & Vertical/ Transmit mode) – High channel

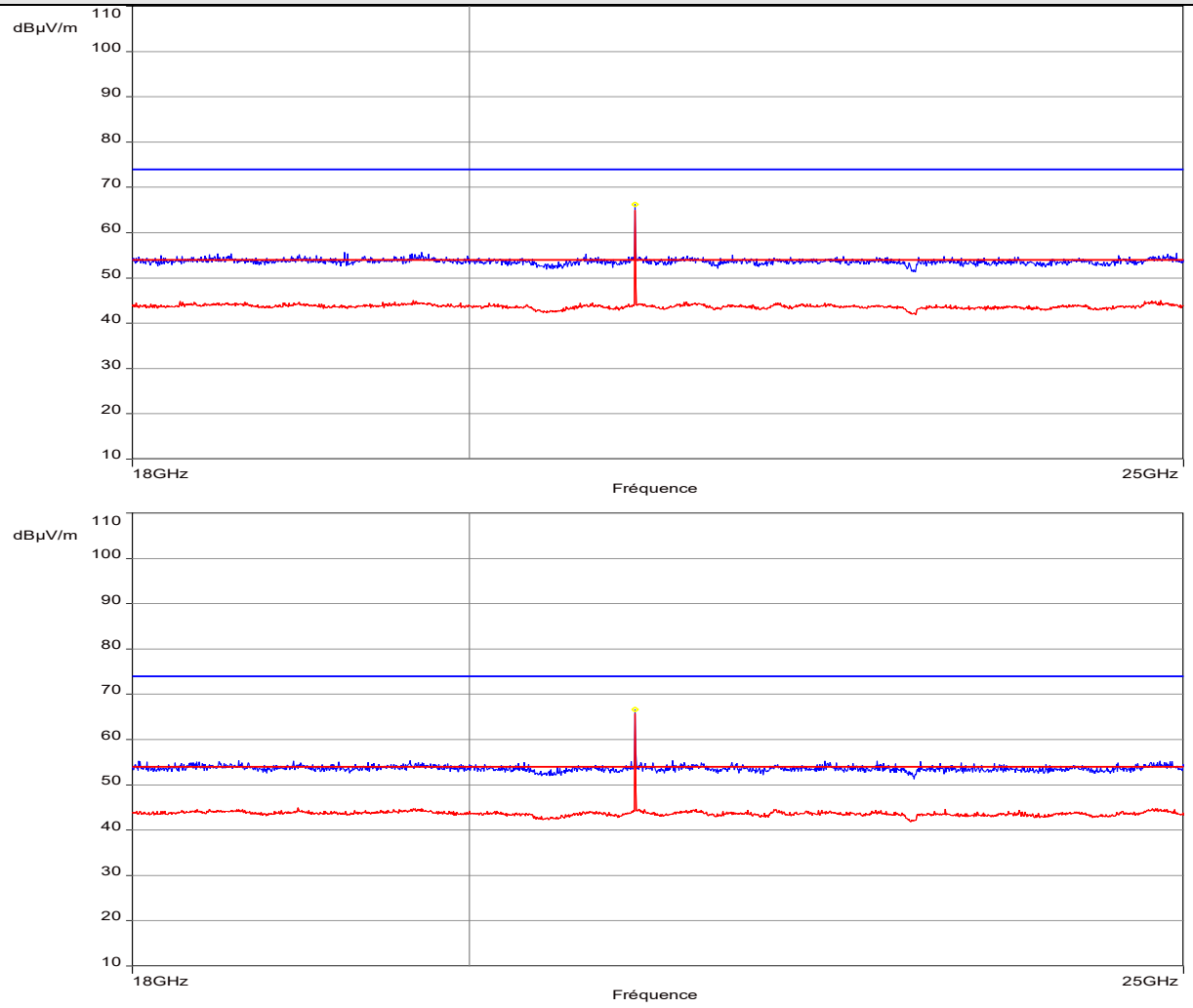


Note: Pre-scan graph only for identification purpose.

------ : Peak measure	------ : Average measure
Frequency band investigated:	1GHz-18GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal & Vertical
Voltage:	12V
Limit:	FCC 15.247 / RSS-247
Measurement detector:	Peak / Average

PEAK LIST FROM PRE-SCAN					
Frequency (MHz)	**Peak Level (dBµV/m)**	**Angle (°)**	**Limit (dBµV/m)**	**Polarization**	**Comments**
2479.8	93.89	20.6	74.0	H	RF / BLE carrier
4959.5	51.98	210.7	74.0	H	
7439.33	52.21	105.6	74.0	H	
10531.3	107.98	16.2	74.0	H	RF / MW radar carrier
2479.8	87.46	96.7	74.0	V	RF / BLE carrier
4959.3	54.6	82.8	74.0	V	
7440.56	51.96	25.2	74.0	V	
10531.3	81.73	96.2	74.0	V	RF / MW radar carrier

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 18GHz-25GHz / 3m / Horizontal & Vertical/ Transmit mode) – Low channel / High channel



Note: Pre-scan graph only for identification purpose. Pre-scan performed at 1m.
Same result for transmit mode on all channels.

------ : Peak measure	------ : Average measure
Frequency band investigated:	18GHz-25GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal & Vertical
Voltage:	12V
Limit:	FCC 15.247 / RSS-247
Measurement detector:	Peak / Average

PEAK LIST FROM PRE-SCAN

Frequency (MHz)	Peak Level (dBµV/m)	Angle (°)	Limit (dBµV/m)	Polarization	Comments
21062.8	66.25	311.3	77.5 (*)	H	RF / MW radar harmonic
21062.8	66.59	47.3	77.5 (*)	V	RF / MW radar harmonic

(*): FCC 15.245 / RSS-210, F.1 limits

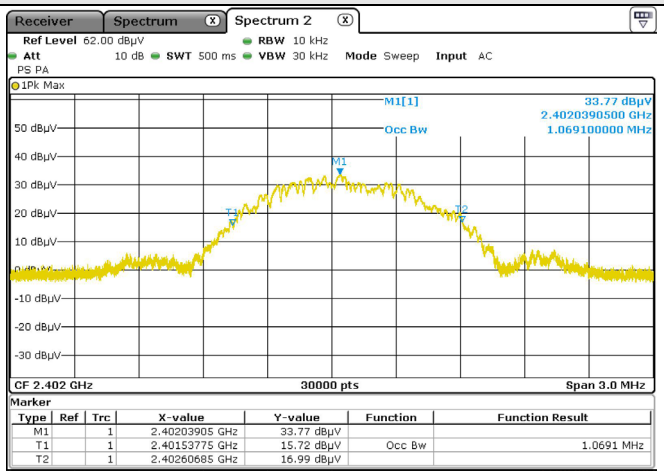
15. Occupied bandwidth (99%)

TEST: Occupied bandwidth (99%) / RSS-GEN		**Verdict**
Method: The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. A radiated measurement is performed. The RBW is set in the range of 1% to 5% of the occupied bandwidth, with VBW ≥ 3 x RBW. The SPAN is wide enough to capture all products of the modulation process. A MaxHold Peak detector is used. Measure is performed with OBW 99% function of the spectrum analyser. The tested equipment is set to transmit operation with modulation on low, mid and high channels.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	56% ± 5
Supplementary information: Test location: SMEE. Test date: October 8th, 2018. Tested by L. CHAPUS		

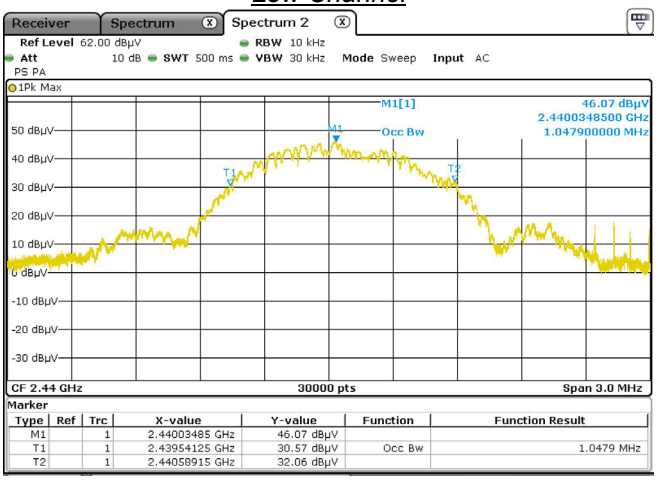
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
RF cable	Pasternack RF	PE302-120	CAB-131-024	2018/4	2019/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2018/4	2019/4
Anechoic chamber	COMTEST	214263	CAG-141-001	2017/6	2020/6
Turntable	Innco- Systems	CT0800	PLA-141-001	-	-
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-003	2017/5	2019/5

Tabulated Results for Occupied Bandwidth	
Frequency (MHz)	**99% Occupied Bandwidth** (MHz)
2402.0	1.0691
2440.0	1.0479
2480.0	1.0506

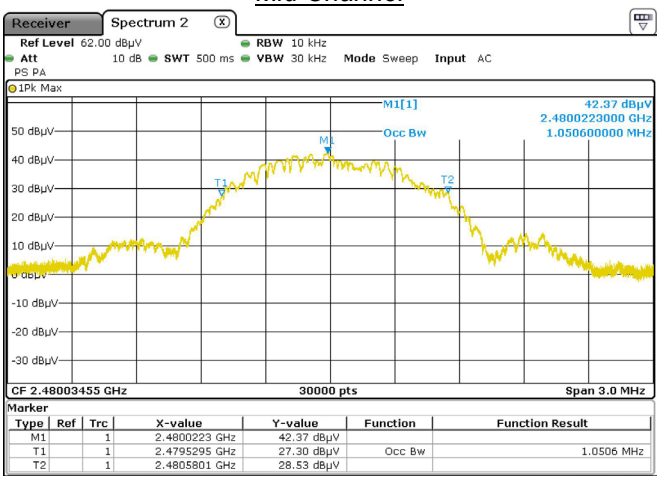
Graphical representation of Occupied Bandwidth



Low Channel



Mid Channel



High Channel

Frequency band investigated:	2400MHz to 2483.5MHz
RBW :	10kHz
Measurement detector:	Peak